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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/623,482	07/18/2003	Michael A. Todd	ASMEX.376A	4562

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EXAMINER	
POMPEY, RON EVERETT	
ART UNIT	**PAPER NUMBER**
2812	

DATE MAILED: 11/03/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/623,482	TODD ET AL.	
	Examiner	Art Unit	
	Ron E. Pompey	2812	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *9-19-05*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-22,38-57,105 and 106* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-22,38-57,105 and 106* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1-22, 38-57 and 105-106 are rejected under 35 U.S.C. 103(a) as being unpatentable over Luo et al. (US 2003/0059535) in view of Cote et al. (US 6,252,295), Admitted Prior Art or Niimi et al. (US 6,503,846).

Lou discloses the limitations of:

depositing a silicon layer on a substrate in a process chamber;

substantially removing the silicon gas from the process chamber;

forming a silicon-containing compound layer by exposing the silicon layer to a reactive species; and

substantially removing the reactive species form the process chamber;

wherein the reaction chamber is a single substrate laminar flow reaction chamber;

wherein depositing a silicon layer comprises chemical vapor deposition;

wherein depositing the silicon layer comprises forming more than one atomic layer of silicon;

wherein the reactive species comprises a nitrogen species and the silicon-containing compound layer comprises silicon nitride;

wherein the nitrogen species comprises ammonia;

wherein the nitrogen species comprises nitrogen active species;

wherein the silicon nitride layer is more uniform than a silicon nitride layer of substantially similar thickness deposited by chemical vapor deposition with silane (is inherent due to the fact the film is being formed from several thin layers building up on each other which would dictate a more uniform layer).

wherein the silicon nitride layer is formed over an interfacial layer((pg. 2, bottom lines of paragraph [0029]));

wherein the interfacial layer comprises silicon oxynitride;

wherein the interfacial layer comprises silicon oxide (pg. 1, bottom sentences of paragraph [0006]: the film deposited comprises one or a combination of SiN, SiO_2 or SiON therefore the complete film will consist of multiple layers of any one or more than one of the Si-based films in any order. So, the first layer of the completed film will be the interfacial layer.);

wherein the oxygen species comprises one or more oxidants selected from the group consisting of atomic oxygen, water, ozone, oxygen, nitric oxide, and nitrous oxide (pg. 5, paragraph [0054]);

wherein the silicon-containing compound layer is formed over hydrogen passivated substrate;

wherein substantially removing the reactive species comprises a removal process chosen from the group consisting of evacuating the reactive species and purging the process chamber with inert gas;

wherein the cycles are repeated until the silicon-containing compound layer has a thickness between about 3 A and 500 A;

wherein the cycles are repeated until the thickness is between about 3 A and 400A;

first, depositing a silicon layer (fig. 1D) on a substrate by exposing the substrate to a silicon source, wherein the silicon layer has a silicon layer thickness between about 3 A and 25 A (pg. 3, paragraph [0035], lines10-16 and pg. 5, paragraph [0051]); and

second reacting (fig. 1E) the silicon layer to partially form the layer of an insulating silicon compound, polysilane (pg. 5, paragraph [0052]) is the silicon source used to deposit a first silicon layer on the substrate in a first performance of a cycle of the plurality of cycles(pg.3, paragraph [0037]);

wherein reacting comprises nitriding and wherein the insulating silicon compound is silicon nitride;

wherein reacting comprises oxidizing and wherein the insulating silicon compound is silicon oxide (pg.5, paragraph [0054]);

wherein the silicon source for depositing subsequent silicon layers after depositing the first silicon layer comprises a silicon compound selected from the group consisting of silanes having a silane chemical formula Si_nH_{2n+2}, where n = I to 4, and halosilanes having a halosilane chemical formula $R_{4-x}SiH_x$, where R = Cl, Br or I and X = 0 to 3;

wherein all silicon layers deposited after the first silicon layer are formed with the same silicon source;

wherein a first substrate temperature for depositing the first silicon layer is less than about 525°C (pg.3, paragraph [0035]);

wherein the first substrate temperature is less than about 475°C (pg.3, paragraph [0032], last 5 sentences);

wherein the second substrate temperature for reacting the first silicon layer is greater than the first substrate temperature (pg.3, last 4 sentences in the first paragraph and pg. 1, paragraph [0005]: page 3 states that non silicon reacting gas can be reacted at different temperature than the silicon reacting gas and page 1 states that temperatures for reacting nitrogen include 650°C which is higher than the 475 °C);

wherein depositing and reacting are performed isothermally after reacting the first silicon layer;

wherein a third substrate temperature for depositing and reacting, after reacting the first silicon layer, is between about 400°C and 650°C (pg. 3, paragraph [0034]);

wherein reacting the silicon layer comprises exposing the silicon layer to an atomic species;

wherein the atomic species is atomic nitrogen;

wherein the reaction chamber is a single substrate laminar flow reaction chamber (pg. 3, paragraph [0038]); and

wherein a temperature for reacting is less than about 650°C.

3. Luo does not disclose the claimed limitation(s) of:

by exposing the substrate to trisilane;

wherein trisilane is the silicon source used to deposit a first silicon layer on the substrate in a first performance of a cycle;

wherein the reaction chamber is a batch reactor;

wherein the interfacial layer is formed by a process comprising: depositing a silicon layer on a substrate by exposing the substrate to trisilane; and forming the interfacial layer by exposing the silicon layer to an oxygen species;

wherein substantially removing the trisilane comprises a removal process chosen from the group consisting of evacuating the process chamber and purging the process chamber with inert gas;

wherein the silicon-containing compound layer has a thickness non-uniformity of about 5% or less;

wherein the silicon-containing compound layer has a step coverage of about 80% or greater;

wherein the layer of an insulating silicon compound has a stiochimetry of about 43 silicon atoms per 56 nitrogen atoms;

wherein the third substrate temperature is greater than about 525^{o}C;

further comprising evacuating the reaction chamber for at least about 10 seconds before reacting the first silicon layer;

wherein the first silicon layer has a first silicon layer thickness of about 8-12 A;

wherein a temperature and a duration for reacting are chosen to prevent reacting the substrate under the silicon layer.

However,

a. Cote discloses the above claimed limitations regarding:

trisilane as a silicon reactive gas in column(s) 2, line(s) 53-57.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to combine Cote with Luo, because Cote shows that trisilane is an equivalent silicon forming reactive gas known in the art. Therefore, because silane, disilane, also disclosed in Luo, and trisilane were art-recognized equivalents at the time the invention was made, one of ordinary skill in the art would have found it obvious to substitute trisilane for silane, disilane or any other silicon forming reactive gases disclosed in Cote and greater film uniformity can be obtained by introducing the higher-order silane like trisilane, see Todd et al. (USPGPUB 20030082300 [0071]), teaching reference). This addresses all claims in the 103 rejection that deal with trisilane.

b. Admitted Prior Art(APA) discloses the above claimed limitations regarding:

wherein reaction chamber is a batch reactor (in page 7, paragraph [0037] of applicant's specification).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to combine APA with Luo, because it is a matter of design choice and applicant has attached no criticality to using a laminar, disclosed in Lou, or a batch chamber for the processing of the films.

c. It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the silicon-containing compound: with a thickness non-uniformity, a step coverage, a silicon to nitrogen stiochimetry, a third

substrate temperature, a time for evacuating the reaction chamber before reacting the first silicon layer and a first silicon layer thickness in the ranges claimed, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or working ranges involves only routine skill in the art. In re Aller, 105 USPQ 233. Optimizing the process to these ranges would provide for a stronger and resistant silicon-containing compound.

d. Niimi discloses that it known in the art to not provide an excessive amount of nitrogen near the interface between the semiconductor substrate and a compound insulator on the substrate. It would have been obvious to one of ordinary skill in the art at the time of the invention was made to provide a thickness of the first silicon layer on the substrate to about greater than or equal to a nitridation saturation depth with the formation of the silicon layer of Lou, in order to not adversely affect the threshold voltage and degrade the channel mobility of the device (see Niimi column 1, lines 63-67).

Also, Lou, page 3, second column, lines 10-15, describes that the silicon layer can be formed to a desired thickness by controlling certain parameters as desired. Time and temperature were included in the parameters listed.

Response to Arguments

6. Applicant's arguments filed 9-19-05, pertaining to claims 1-22, 38-57 and 105-106, have been fully considered but they are not persuasive. The applicant argues that the examiner does not show why the skilled artisan would "substitute trisilane for

silane.". However, an additional reason of forming a SiN layer with a greater uniformity by using a higher order silane source gas is given to further express why you would replace silane with trisilane, see the teaching art listed above. Therefore, because the art has not changed the rejection has not changed.

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Todd et al. (USPGPUB 20030082300) discloses forming a SiN layer using trisilane as a source gas.

2. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ron E. Pompey whose telephone number is (571) 272-1680. The examiner can normally be reached on compressed.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael S. Lebentritt can be reached on (571) 272-1873. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Ron Pompey
AU: 2812
October 28, 2005

MICHAEL LEBENTRITT
SUPERVISORY PATENT EXAMINER